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ARTICLE

Comparison of reading performance between visually impaired and normally sighted students in Malaysia

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ABSTRACT The aim of this study is to compare reading performance between visually impaired and normally sighted school children. Participants (n = 299) were divided into three groups: normal vision (NV, n = 193), visually impaired print reader (PR, n = 52), and Braille reader (BR, n = 54). Reading performance was determined by measuring reading rate and comprehension. ANOVA was used to compare the results. A statistically significant difference was found in reading rate between the three groups ($p < 0.0001$). The BR had the lowest reading rate compared to other groups. Only a small percentage of the visually impaired children were able to achieve a reading rate within the normal values of normally sighted children. Results of the comprehension test showed no significant difference in the scores of the three groups ($p = 0.232$). The findings of this study suggests that visually impaired students required a longer time to read and understand a text and this has implications on the time given to them, especially during examinations.

KEY WORDS *Braille reader, comprehension, print reader, reading rate, visually impaired*

INTRODUCTION

Reading is one of the essential skills that needs to be acquired early in life. Reading involves two types of processes; micro or low-level process of decoding words and macro process corresponding to understanding

of text (Gonzalez Garcia, 2004). Vision, is one of the many factors that influence the ability to develop reading skills. Anomaly in the visual system could impede reading process and consequently affect reading performance. Children with low vision will experience degraded visual input and need more time and effort for word recognition when reading. As a result, less processing capacity and working memory is left for understanding the text (Gompel et al., 2004). Studies on comprehension of low vision children showed different results. One study compared reading performance of low vision students with their age-matched sighted peers using the Neale Analysis of Reading Ability (Douglas et al., 2002). They found that low vision students lag behind in all aspects of reading, namely accuracy, speed, and comprehension. Another study however, found that children with low vision need more time to read and comprehend a text; but they seem to use this time with enough efficiency to process semantic and syntactic information (Gompel et al., 2004). Thus, children with low vision are as good as sighted children in comprehending text (Gompel et al., 2002)

Braille reading has been described in a manner similar to print reading in terms of the developmental stages involved. Steinman et al. (2006) for example, used the Chall's model to equate Braille reading to print reading in all the stages of reading development. There are differences however, which have been largely attributed to the micro process of reading. It has been shown that in Braille reading, information is obtained letter by letter while touching as opposed to groups of letters per fixation in print reading (Nolan and Kederis, 1969). Thus, Braille reading rate is said to be lower because each alphabet that makes up the whole word needs to be identified one at a time prior to word identification. Furthermore, the letter information must be stored longer in working memory to allow integration with previously stored information (Gonzalez Garcia, 2004). This suggests that although some of the processes involved in reading among print and Braille readers are very similar, reading rate will be different between them.

In Malaysia, visually impaired students are usually placed in special schools. These schools cater for both low vision and blind students. Learning instruction for the students depends on their visual ability; hence, either print or Braille is used in teaching and learning. The objective of this study is to compare the reading performance of visually impaired students in the special school with their normally sighted peers in a mainstream school. Reading performance is measured using reading rate and comprehension. The hypothesis would be that the visually impaired students who read using print or Braille will have

poorer reading rate and comprehension because they need to devote more attention in the decoding process than in text comprehension. The results found in this study will be useful to teachers particularly to the time given to students during examinations. The examination syndicate under the Ministry of Education, Malaysia, allowed extra time during public examination for a special needs student. The same amount of extra time is given to all students with special needs including those with vision impairment.

METHOD

Samples

The study involved 299 students from two schools, one mainstream and one special school in Kuala Lumpur, Malaysia. The schools are secondary level, typically for students in the age range of 13 (Form 1) to 18 (Form 6) years old. The education system in Malaysia however allows students to remain in special schools for another two years until they are 20 years old. For the purpose of comparison, students from the special school were divided into two groups: Print Reader (PR) and Braille Reader (BR): 52 participants in the PR group (25 males and 27 females) and 54 in the BR group (30 males and 24 females). The remaining 193 (95 males and 98 females) were from the mainstream school and they will be referred to as Normal Vision (NV). The language of instruction for both schools is mainly Malay.

Materials and Procedures

The following data was collected from the participants in both schools: biodata, medical history from available medical records in school (only for special school), distance visual acuity (VA) using Bailey-Lovie logMAR chart, near visual acuity using Malay language near chart test, and reading performance. Informed consents were obtained prior to data collection. The data collection for all participants was done at their respective schools. Students at the special school who owned low vision devices were tested with their devices for distance and near VA as well as reading performance. Only 11 of the visually impaired students had their own low vision devices. Those who require further low vision evaluation were referred to the Low Vision Clinic at Universiti Kebangsaan Malaysia. At the end of the study, about 38 percent (n = 40) of the visually impaired students were prescribed with optical or non-optical devices to facilitate their reading. Results of the intervention have been described elsewhere (Omar et al., 2009)

Reading performance was measured in two ways; reading rate and comprehension. Prior to that, a number of reading charts were constructed to measure reading performance. This was done after discussion with teachers at the schools because there was no standardized Malay language chart developed for such a purpose when the study was conducted. The charts used for measuring reading rate consist of random words, with no meaning between the adjacent words. This is done to avoid the use of context in decoding the word. Studies of sighted children showed that a meaningful context facilitated reading process (Nation and Snowling, 1998; Stanovich et al., 1981). Similar effect of context has been reported for low vision readers (Bullimore and Bailey, 1995).The charts were printed in various sizes similar to the font size used in Bailey-Lovie word reading chart (Bailey and Lovie, 1976). The examiner selects a chart with font size one step bigger than the student's near acuity. They were asked to read aloud while the examiner noted time taken to complete the task and errors made. Errors include mispronunciation, substitution, addition or omission. Reading rate is calculated as the number of correctly read words per minute (wpm). Some of the visually impaired children, particularly Braille Readers read at very low rate. In this situation, the examiner stopped the watch and allowed them to take a short break. This way, the influence of fatigue on reading performance can be controlled to a certain extent, albeit not totally eliminated.

Participants were asked to rest for a short while before measurement of reading comprehension took place. Reading comprehension was measured using different test charts. The charts consist of various articles in Malay language selected by the school teachers. They were printed in various font sizes. Students were asked to read the article silently and answer 10 multiple-choice questions without referring back to the article. No time limit was imposed to complete the tasks for comprehension. The time taken for the students to complete the task was not recorded. Results are presented in percentage of correct answers. The same charts used for testing reading rate and comprehension were converted to Braille by the special school teachers to test Braille readers. Data was analysed using SPSS version 16. Normality was tested using Kolmogrov Smirnov for normal vision students ($n > 100$) and Shapiro-Wilks test for the visually impaired ($n < 100$).

RESULTS

The age distribution of the schoolchildren who participated in the study is shown in Table 1. First, reading rate of each age group for PR, BR and

Table 1. Gender, age distribution and comparison of reading rate for each age group of the three groups (PR: visually impaired print reader, BR: Braille reader, and NV: Normal Vision)

	Gender		Age							ANOVA (comparison of reading rate for each age group)
Group	Male	Female	13	14	15	16	17	18	19	
PR (n = 52)	25	27	6	6	12	18	7	2	1	F (6, 0.817) p = 0.562
BR (n = 54)	30	24	8	9	9	10	11	4	2	F (6, 0.688) p = 0.660
NV (n = 193)	95	98	32	38	32	39	48	4	–	F (5, 0.980) p = 0.432

NV were compared using one-way between group analysis of variance (ANOVA). The results of the analysis showed no significant difference in reading rate of each age group for all three groups (Table 1). Therefore, data from all age groups were combined in the next analysis. Furthermore, the number of students for each age group is quite small for PR and BR.

The Mann-Whitney U test was used to compare VA at distance and near between visually impaired PR and NV students. As expected, PRs have significantly poorer acuity compared to NV at distance (U = 103.00, z = –10.922, $p < 0.0001$) and near (U = 167.0, z = –13.166, $p < 0.0001$). Mean distance VA for PR is 1.14 logMAR (6/75) compared to 0.01 logMAR (6/6) for NV. Mean near VA for PR is 27.92 as compared to 4.21 for NV. Summary of mean, median, standard deviation and 95% CI for each group are shown in Table 2.

Comparison of reading rate for the three groups (PR, BR, and NV) was initially done by plotting the reading rate of each student on the same graph (Figure 1). It can be seen that the reading rate of BR and PR are lower than those in NV. A number of the students in PR group however, showed high reading rate exceeding 100 wpm.

A more meaningful comparison between the three groups can be made using one-way between group analysis of variance (ANOVA). The result was found to be statistically significant, F (2,296) = 138.99, $p < 0.0001$. Post hoc analyses with the Dunnett T3 test was carried out for multiple

Table 2. Mean, Standard Deviation (*SD*), median, Lower and Upper Bound at 95% confidence interval (CI) for distance and near visual acuity for visually impaired Print Reader and Normal Vision

	Print Reader (PR)					Normal Vision (NV)				
	Mean	SD	Median	Lower Bound (95% CI)	Upper Bound (95% CI)	Mean	SD	Median	Lower Bound (95% CI)	Upper Bound (95% CI)
VA (distance) LogMAR	1.14	0.39	1.16	1.03	1.25	0.01	0.06	0.00	–0.01	0.02
Snellen equivalent	(~6/75)		(~6/95)	(~6/60)	(~6/95)	(~6/6)		(6/6)	(~6/6)	(~6/6)
VA (near)	7.92	19.57	24.00	22.36	33.48	4.21	0.61	4.00	4.13	4.29

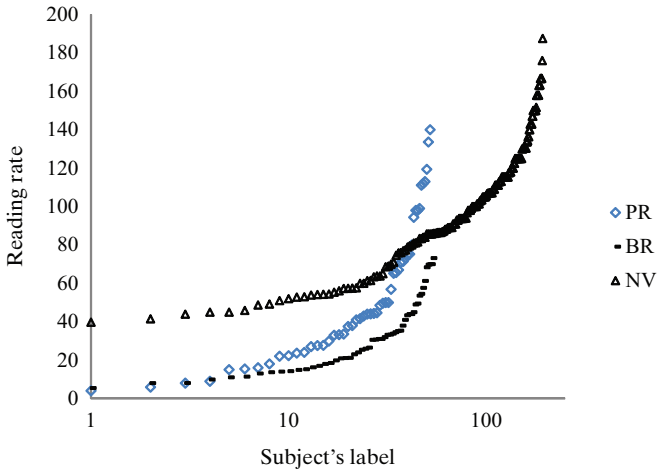

Figure 1. Reading rate for each student in the three groups (PR: visually impaired Print Reader, BR: Braille Reader, NV: Normal Vision)

comparisons between the three groups. The results are shown in Table 3 where significant difference was found between NV and PR ($p < 0.0001$), NV and BR ($p < 0.0001$), as well as PR and BR ($p = 0.001$). Mean reading rate for NV is 103.98 ± 32.02 wpm, PR is 53.66 ± 35.02 wpm, and BR is 33.27 ± 19.83 wpm. Table 4 shows the results of mean, *SD*, Lower and Upper Bound (95% CI), and maximum and minimum value of reading rate for each group.

As mentioned earlier, a number of students in the PR group seems to demonstrate a high reading rate which is within the normal values of NV. To confirm this, the lower bound (95% CI) of NV reading rate is used as the marker for the lower limit of normal values and this is about

Table 3. Results of the multiple comparisons between the three groups using Dunnett T3 test (PR: visually impaired print reader, BR: Braille reader, and NV: Normal Vision)

Reading rate (Group comparison)	Mean Difference	Standard Error	Sig.	95% CI	
				Lower Bound	Upper Bound
NV versus PR	50.32	5.38	<0.0001	37.21	63.44
NV versus BR	70.71	3.55	<0.0001	62.14	79.29
PR versus BR	20.89	5.56	0.001	6.85	33.93

Table 4. Mean, Standard Deviation (*SD*), Lower and Upper Bound at 95% CI and, max and min reading rate for the three groups (PR: visually impaired print reader, BR: Braille Reader, and NV: Normal Vision)

				95% CI			
Group	*n*	Mean	*SD*	Lower Bound	Upper Bound	Minimum	Maximum
PR	52	53.66	35.02	43.91	63.41	4.00	140.00
BR	54	33.27	19.83	27.86	38.68	5.47	87.30
NV	193	103.98	32.02	99.44	108.53	39.73	187.50

Table 5. Mean, Standard Deviation (*SD*), Lower and Upper Bound at 95% CI and, max and min comprehension test for the three groups (PR: visually impaired print reader, BR: Braille Reader, and NV: Normal Vision)

				95% CI			
Group	*n*	Mean	*SD*	Lower Bound	Upper Bound	Minimum	Maximum
PR	52	77.31	18.27	82.39	72.22	30	100
BR	54	73.33	22.98	79.61	67.06	10	100
NV	193	78.29	17.61	80.79	75.79	10	100

99.44 wpm (Table 4). It was found that six (11.5%) of the students in the PR group are able to achieve normal reading rate. None of the BR however, achieved normal reading rate. On the other hand, Figure 1 also showed that some of the students in the NV group have a very low reading rate. The upper bound (95% CI) of the PR reading rate is used as the marker for the upper limit of reading rate of visually impaired children and this is about 63.41 wpm. It was found that 27 (13.4%) of the children in the NV group have a reading rate within the normal values of visually impaired students.

Comparison of comprehension test between the three groups was also done using ANOVA. No significant difference was found between the three groups, F (2,296) = 1.468, p = 0.232. Mean, *SD*, Lower and Upper Bound (95% CI), and maximum and minimum value of the comprehension test for each group are shown in Table 5.

DISCUSSION

Reading performance of the schoolchildren was measured in two ways: reading rate and comprehension. The results of the statistical analysis for the two tasks are different. On one hand, reading rate is significantly different between the three groups. The mean reading rate of visually impaired print reader (PR) is 53.66 ± 35.02 wpm, visually impaired Braille reader (BR) is 33.27 ± 19.83 wpm, and normally sighted reader is 103.98 ± 32.02 wpm. In other words, it takes almost twice the time for the students with vision impairment to read this print material and three times longer for a Braille reader to read Braille. This can be translated to longer time in accessing information, e.g. while studying and during examination.

A similar trend of reduced reading rate among visually impaired readers has been reported in other studies. Legge et al. (1999) found that the median for Braille reading rate of experienced readers tested using adapted MNRead test is 124 wpm. They made a comparison to normally sighted and low vision participants reading printed MNRead reported in another study (Mansfield et al., 1996). They found low vision reading print and Braille readers have similar reading rate but their median reading rate is at the 50th percentile of the normally sighted readers. In other words, visually impaired readers have a reading rate two times lower than normally sighted readers. Wetzel and Knowlton (2000) compared reading rate of normally sighted and Braille readers performing three types of reading tasks – oral, silent, and studying. Considering reading tasks that are similar to our study (oral reading), they found the mean reading rate for normally sighted readers is 1.3 times higher than Braille readers (183.85 wpm compared to 134.26 wpm for Braille readers, although their study involved adults).

The mean reading rate for all three groups found in our study seems to be lower compared to other studies reported in the past. However a direct comparison to previous findings is probably not possible because various factors can influence an individual's reading speed. Maximum reading speed of an individual vary according to the cognitive and processing demand of the material, print layout, individual's visual skills, and tasks (Bailey et al., 2003). For example, reading aloud reduces reading rate as compared to reading silently (Carver, 1990), inexperienced readers will have a lower reading rate and the use of random words slows reading compared to meaningful text (Bullimore and Bailey, 1995; Nation and Snowling 1998; Stanovich et al., 1981).

Our study involved schoolchildren, and although their age ranged from 13 to 19 years old, reading rate was not significantly different when comparisons were made across the different age groups. However, we are not sure if they have achieved maximum reading rate of an adult as this was not tested.

Legge et al. (1999) noted in their study that some of the Braille readers matched or exceeded the reading rate achieved by some of their normally sighted participants. We found six participants from PR group had a reading rate within the normal values of NV but none for BR (PR with a higher reading rate will be referred to as fast PR from here on). The characteristics of the six fast PR were compared, but no trend was observed. Their age ranged from 13 to 16 years old, distance VA from 0.88 logMAR (~6/48) to 1.6 logMAR (6/240) and near acuity from N24 to N80. None of them use low vision devices to read. We also noted that the 11 visually impaired students who used low vision devices to read did not demonstrate a fast reading rate. It is possible that the use of low vision devices enhances visual resolution but the field of view restriction imposed by the magnification systems may limit reading efficiency (Ahn and Legge, 1995; Leat and Woodhouse, 1993).

Comparison of comprehension tests between the three groups on the other hand, showed no significant difference between them. Comprehension scores for PR are very similar to NV, implying that degraded vision and slow reading speed have little effect on their understanding. Gompel et al. (2004) studied the semantic and syntactic processing of students with low vision. They found that although low vision children need more time to read and comprehend a text, they are able to use the time with enough efficiency to process information similar to their normally sighted peers. As no time limit was imposed in our study, the visually impaired students were able to read the text at their own reading rate and demonstrate good comprehension similar to their sighted peers. Nevertheless, in some situations for example during examination, time constraints mean that students have to make trade-offs between speed and comprehension. This may explain some of the discrepancies found in past studies.

CONCLUSION

The results of our study suggest that the visually impaired students using print or Braille, read, on average, at a significantly lower rate for these reading tasks. The findings suggest that a longer time is needed for students with vision impairment to understand information particularly

when studying and during examination. The current practice in the Malaysian education system is to allow visually impaired students to have extra time during examination. The extra time of thirty minutes is given as a blanket to all students regardless of their reading rate. Based on the sample of students that were tested in this study, only a small percentage of them are fast readers and most would have benefitted from the extra time given during examination. The majority of the visually impaired students tested were two to three times slower than their normally sighted peers. This means they will have less time to comprehend the questions because they will be concentrating on decoding letters and words. Ideally, the extra time to be allotted to each student should suit their reading speed. This may not be possible to implement, but a general increased extension of time compared to current practice should be considered.

Fatigue is one of the important factors that should be considered when measuring reading performance. In view of this, students were allowed to have as much time as they needed when comprehension was tested in this study. Hence, no significant difference was found for comprehension scores between the visually impaired and normally sighted schoolchildren. Generalization of our findings to other situations, e.g. during exams might not be possible because students may have to compromise their understanding due to time constraints. On the other hand, student's ability is not truly reflected because they could have performed better had they been given more time during exams. The reading materials used in this study also imposed a limitation to our findings. Unfortunately, there was no standardized Malay language chart developed when this study was conducted. Not many studies have been carried out to address the issue of reading among visually impaired students in Malaysia. More studies are needed in view of the long-term implication of education on employment opportunities of these students.

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